Modeling of SMBI experiments based on Monte-Carlo simulation in GAMMA 10

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Gas fueling control is one of the most important issues to obtain good performance plasmas. Fueling control enables the profile control of the core plasma density and reduction of neutral particles in the peripheral area. Supersonic molecular beam injection (SMBI) technique, which has been developed by L.Yao et al.[1, 2], is a new method of gas fueling. SMBI can inject neutral particle deeper into the core plasma compared to the gas puffing. SMBI is successfully applied to some devices [3-5].

SMBI system is installed in GAMMA 10. SMBI is located at the bottom of the central-cell mid-plane. The first results of SMBI showed that SMBI achieved higher density plasmas at the core region than the conventional gas puffing case. A fast camera has been installed at the central-cell in order to observe plasma behavior. The camera system has two lines of sight in the horizontal and vertical direction of the cross-section by using dual branch optical fiber bundles. It is observed that the penetration depth of SMBI determined from the emission brightness was longer than that of gas puffing.

In order to interpret above observation results, DEGAS three-dimensional Monte-Carlo code [6, 7] for neutral transport simulation has been applied to GAMMA 10 [8]. In a whole area of the central-cell vacuum vessel, a detailed 3-D mesh structure for the simulation was constructed. Transport of neutral particles from SMBI can be simulated by using the DEGAS code.

In this paper, we will describe the detail of the simulation geometry for SMBI and the simulation results carried out under conditions of various energies of neutral particles and of various positions of SMBI. Effective operation method of SMBI is also discussed based on the 3-D simulation.

[1] L. Yao, in “New Developments in Nuclear Fusion Research” (Nova Sci. Pub, pp. 61-87 2006).
[2] L. Yao, et al., Nucl. Fusion **47**, 1399 (2007).
[3] L. Yao, et al., Nucl. Fusion **44**, 420 (2004)
[4] P´egouri´e B. et al 2003 J. Nucl. Mater. **313–316** 539
[5] T. Mizuuchi, et al., Contrib. Plasma Phys. **50**, No.6-7, 639 – 645 (2010)
[6] D. Heifetz, D. Post, M. Petravic et al., J. Comput. Phys. **46**, 309 (1982).
[7] Y. Nakashima, et al., J. Plasma Fusion Res. SEREIS **6**, 546 (2004)
[8] Y. Nakashima, et al., Contrib. Plasma Phys. **48**, No. 1-3, 141 – 146 (2008)